Preliminary analysis of reverberation data in ASIAEX experiment*

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Outline

- 1. Source level of bombs
- 2. Monostatic reverberation
- 3. Bistatic reverberation
- 4. The horizontal direction of monostatic reverberation and bistatic reverberation by the beam forming of horizontal array.

1. Source level of bombs

- Two kinds of bombs
- 1). 38g bombs detonated in 50m,

  Distance between receiver and source: R=14m;
- 2). 1kg bombs detonated in 50m

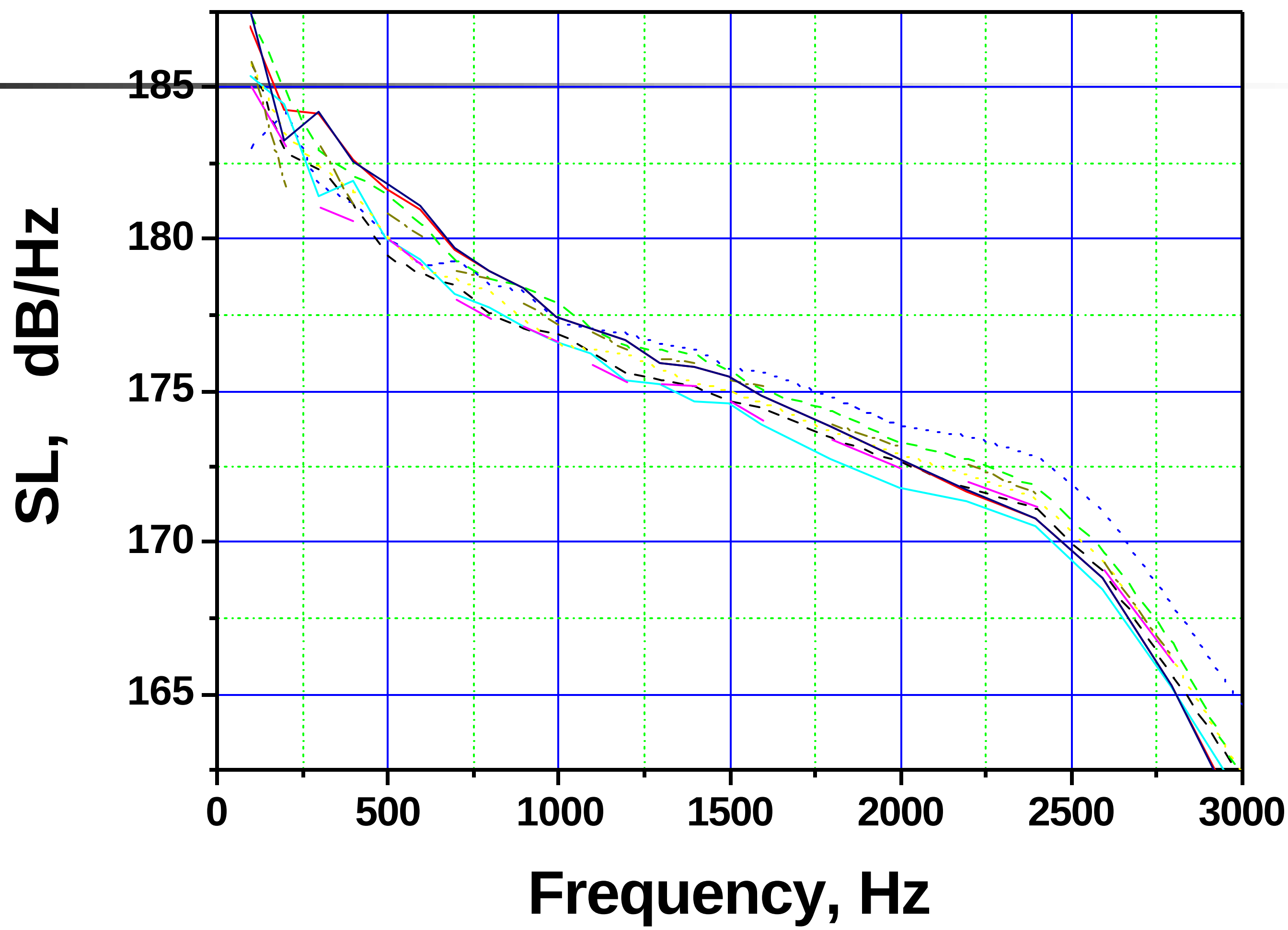

Fig1. Source level of 38g bombs

- Two assumptions:
- 1)Reverberation strength is only related to source level and the environmental parameters and the depths of receiver and source.
- 2)The change of ocean environment is not very quickly.

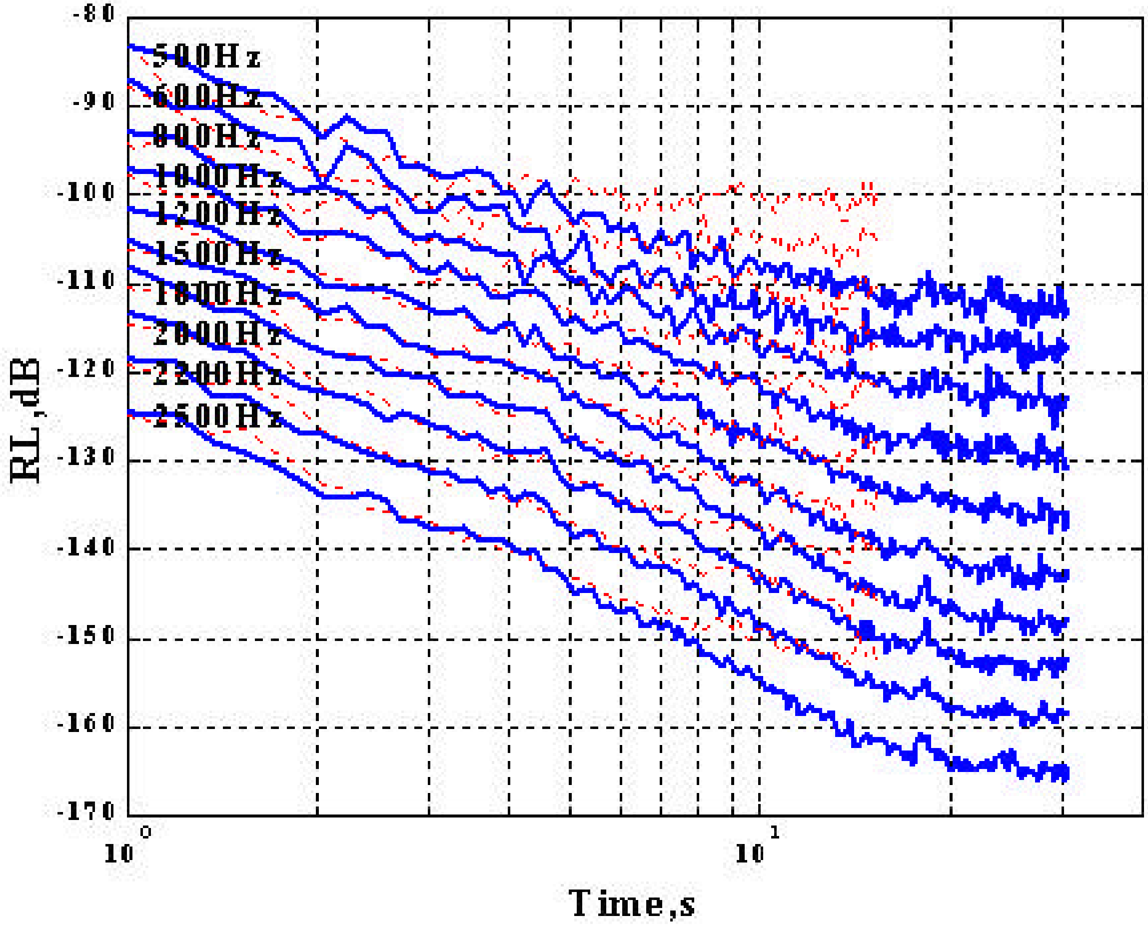

Fig2. Comparison of reverberation loss of 38g and 1kg bomb. Receiver depth 32m.

Difference between 38g bomb SL and 1kg bomb SL

Frequency (Hz)	500	600	800	1000	1200	1500	1800	2000	2200	2500
Difference in 32m (dB)	13.4	13.0	12.8	13.3	13.9	13.8	14.1	13.8	13.4	13.0
Difference in 90m (dB)	12.9	12.8	13.9	14.3	14.1	13.7	13.6	13.2	12.9	12.9

2. Monostatic Reverberation

Reverberation loss:

$$RL = SL - 10 * \log 10 I_{rev}$$

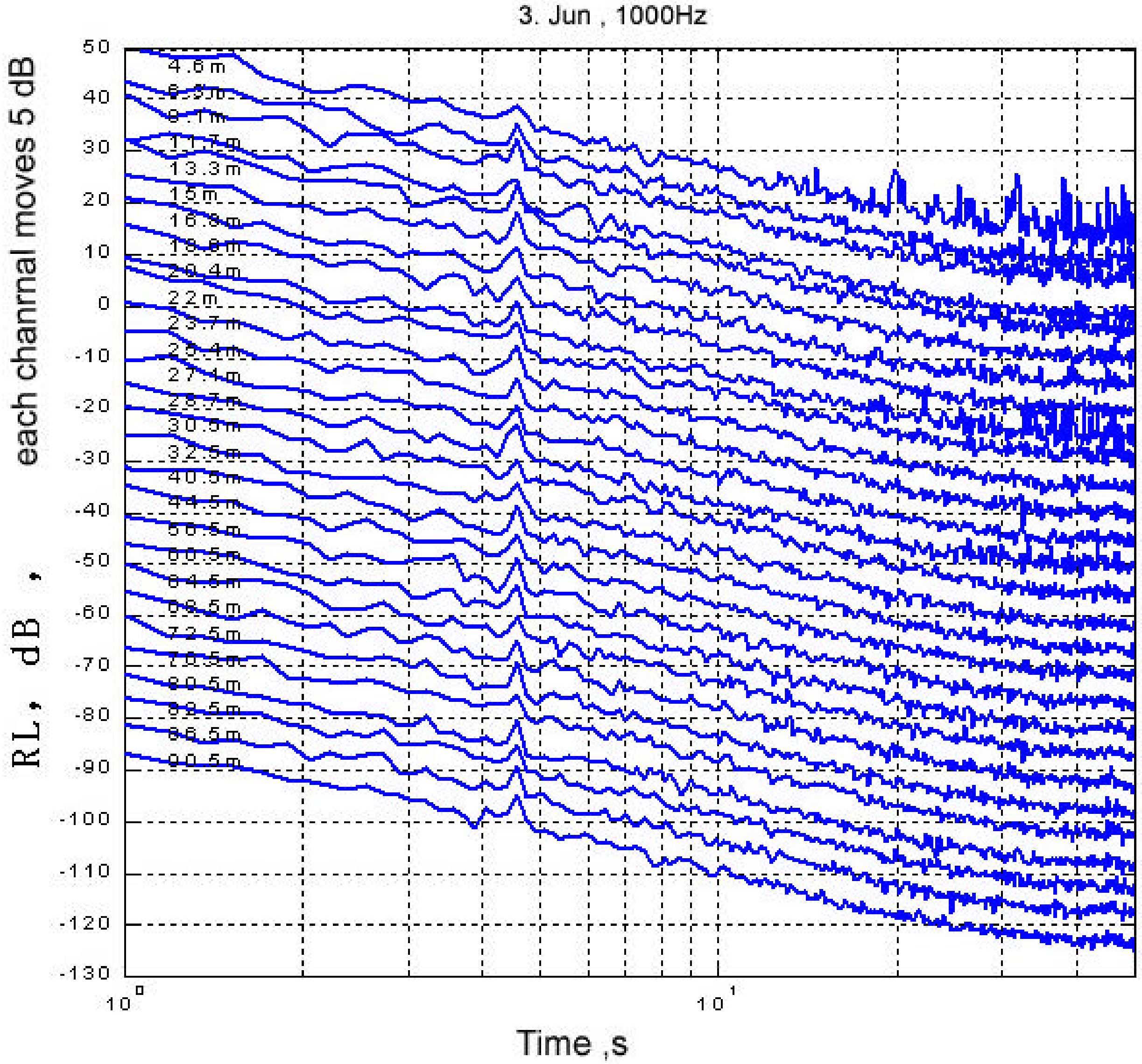

Fig3. Comparison of reverberation loss recorded by VLA. Frequency 1000Hz.

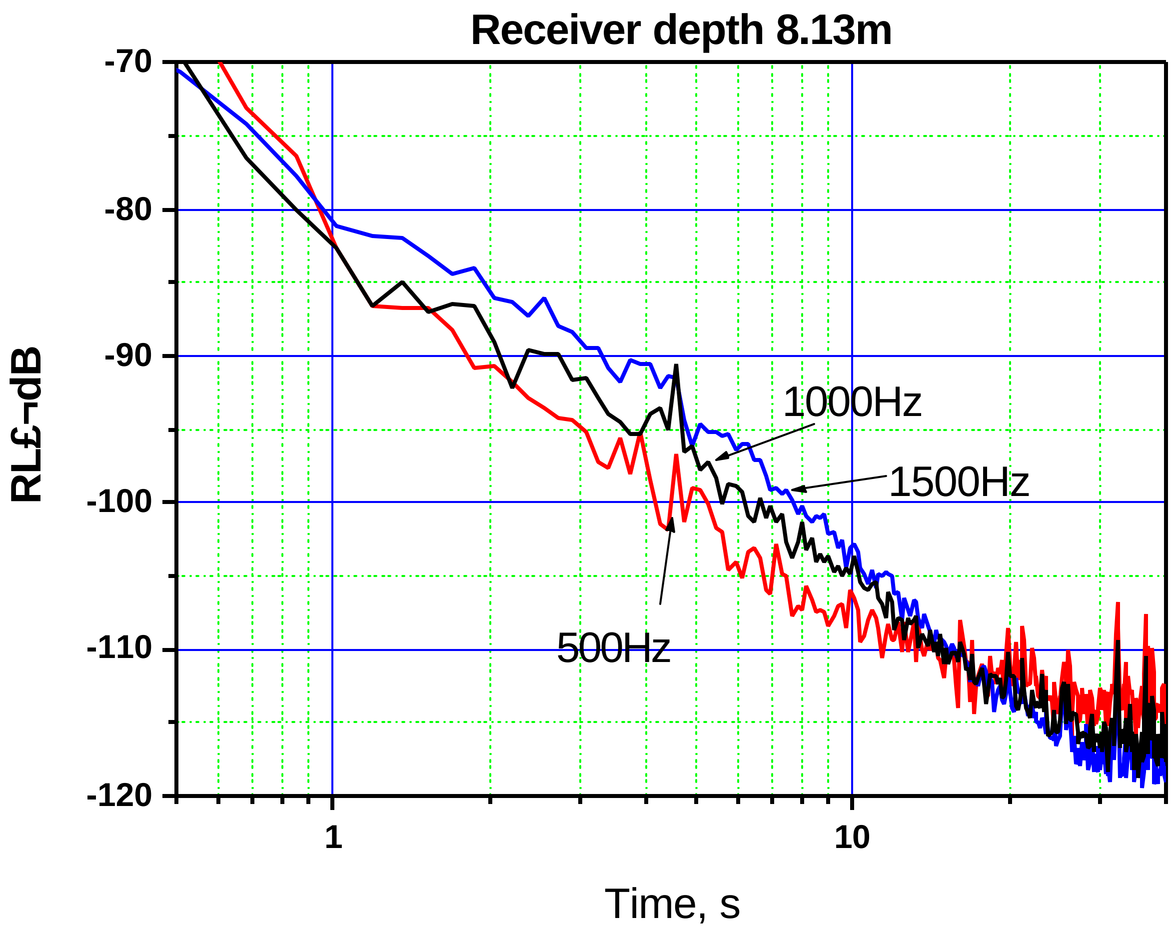

Fig4. Comparison of different frequency reverberation loss at the depth 8m.

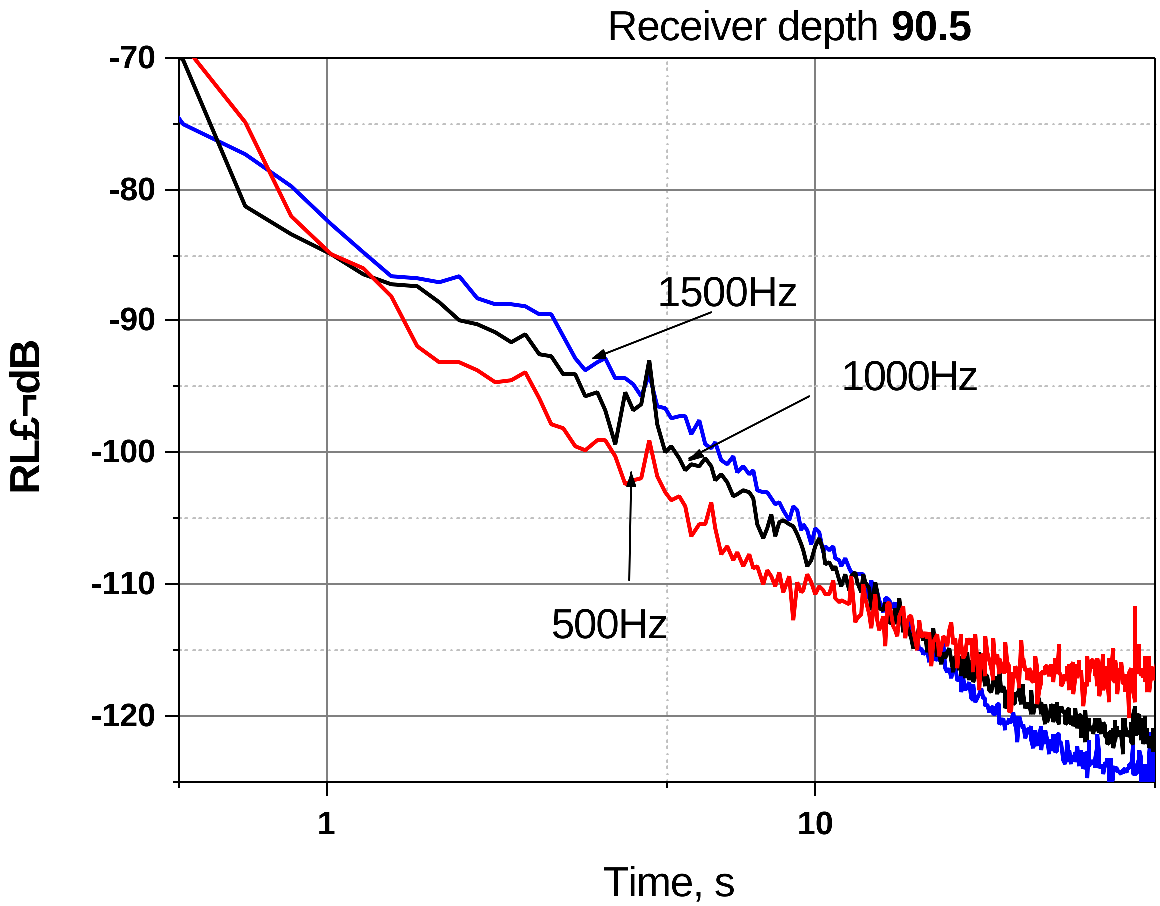

Fig5. Comparison of different frequency reverberation loss at the depth 90m.

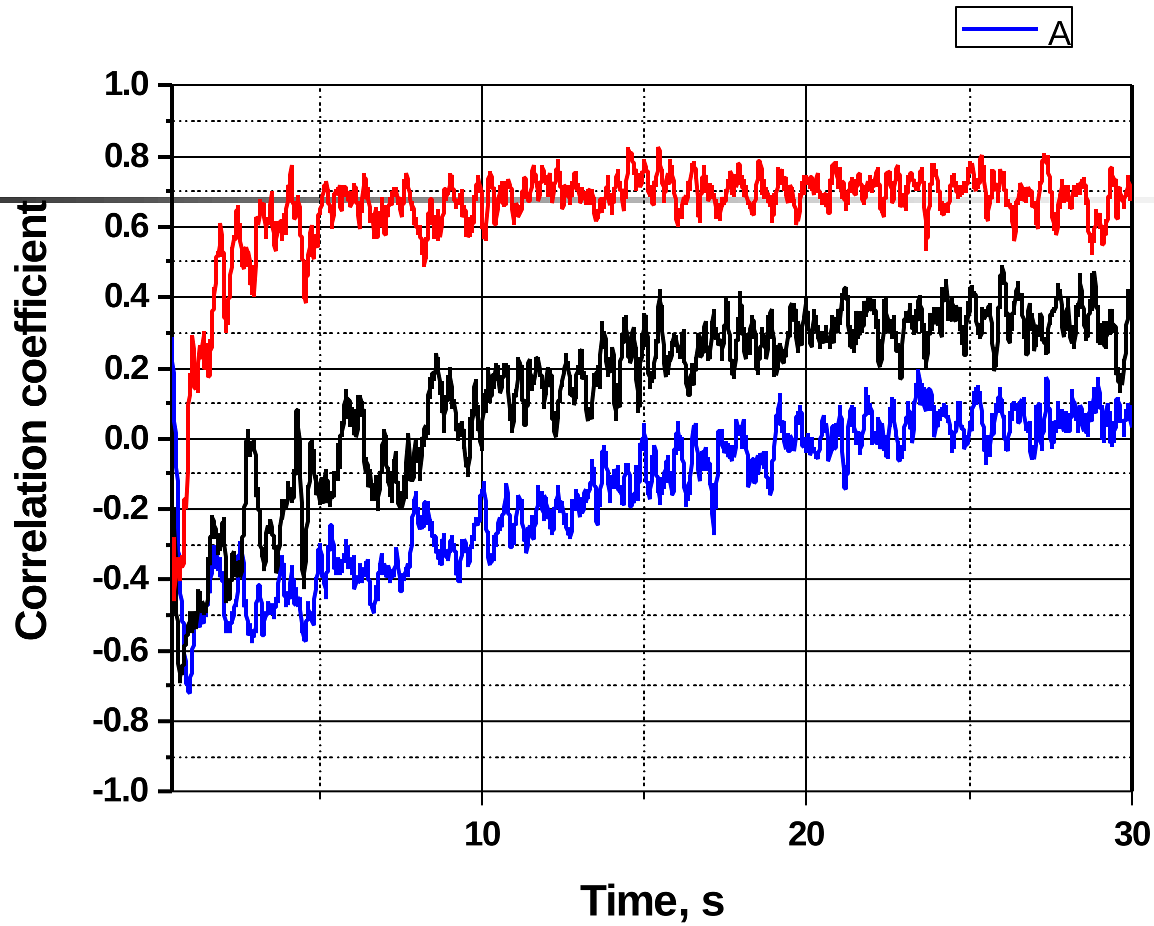

Fig6. Comparison of different frequency vertical correlation, Receivers depths are 80.5m and 82.5m. Frequency 500Hz(red), 1000Hz(black), 1500Hz,(blue).

3. Bistatic reverberation

- Distance between 1kg bomb source and receivers:

$$r_0=7.6km;$$

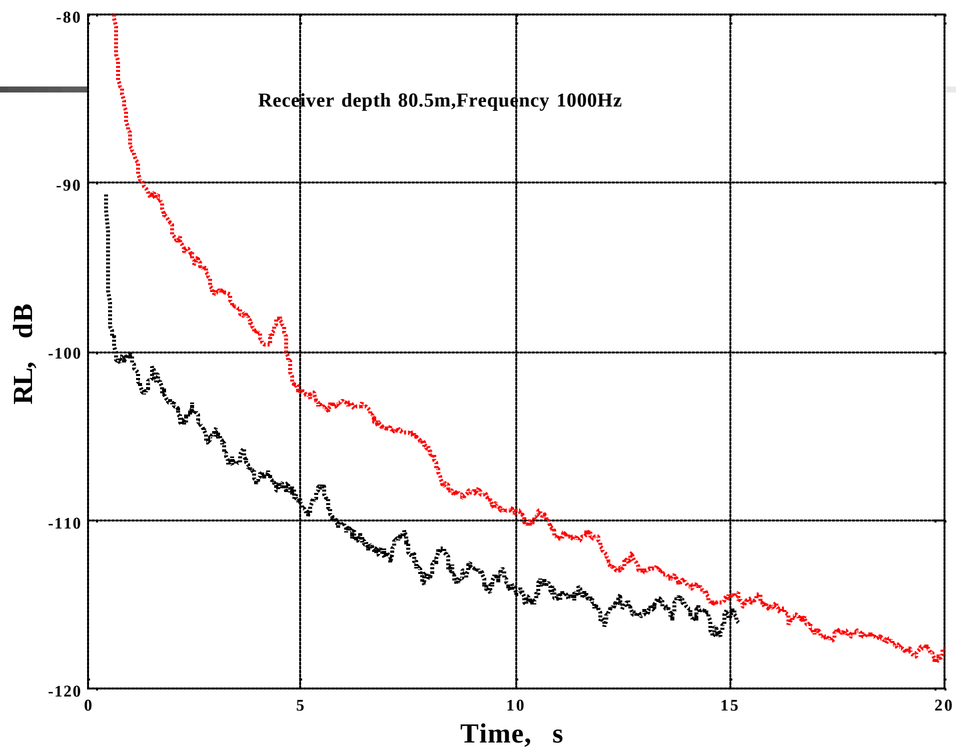

Fig7. Comparison of monostatic(red) and biastaic(black) reverberation loss, receiver depth 80m,frequency 1000Hz

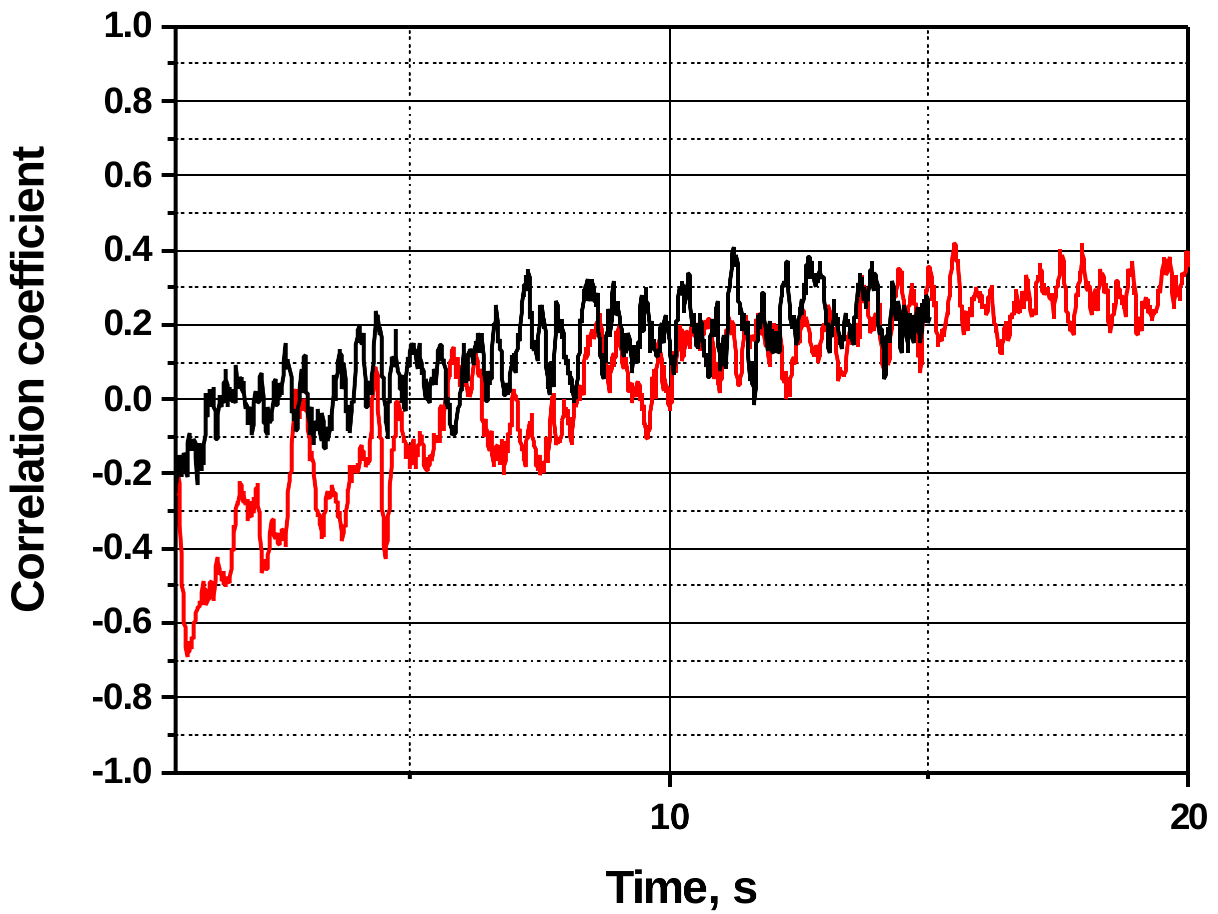

Fig8. Comparison of monostatic(red) and bistatic(black) reverberation vertical correlation, receivers depths: 80.5m and 82.5m, frequency 1000Hz.

Normal mode theory based on ray-mode analogies and three dimension scattering model:

- When $t > 2r_0/c$:

- 1): $I_{bi}(t) \sim I_{mo}(t + r_0/c)$
- 2): $?_{bi}(t) \sim ?_{mo}(t + r_0/c)$

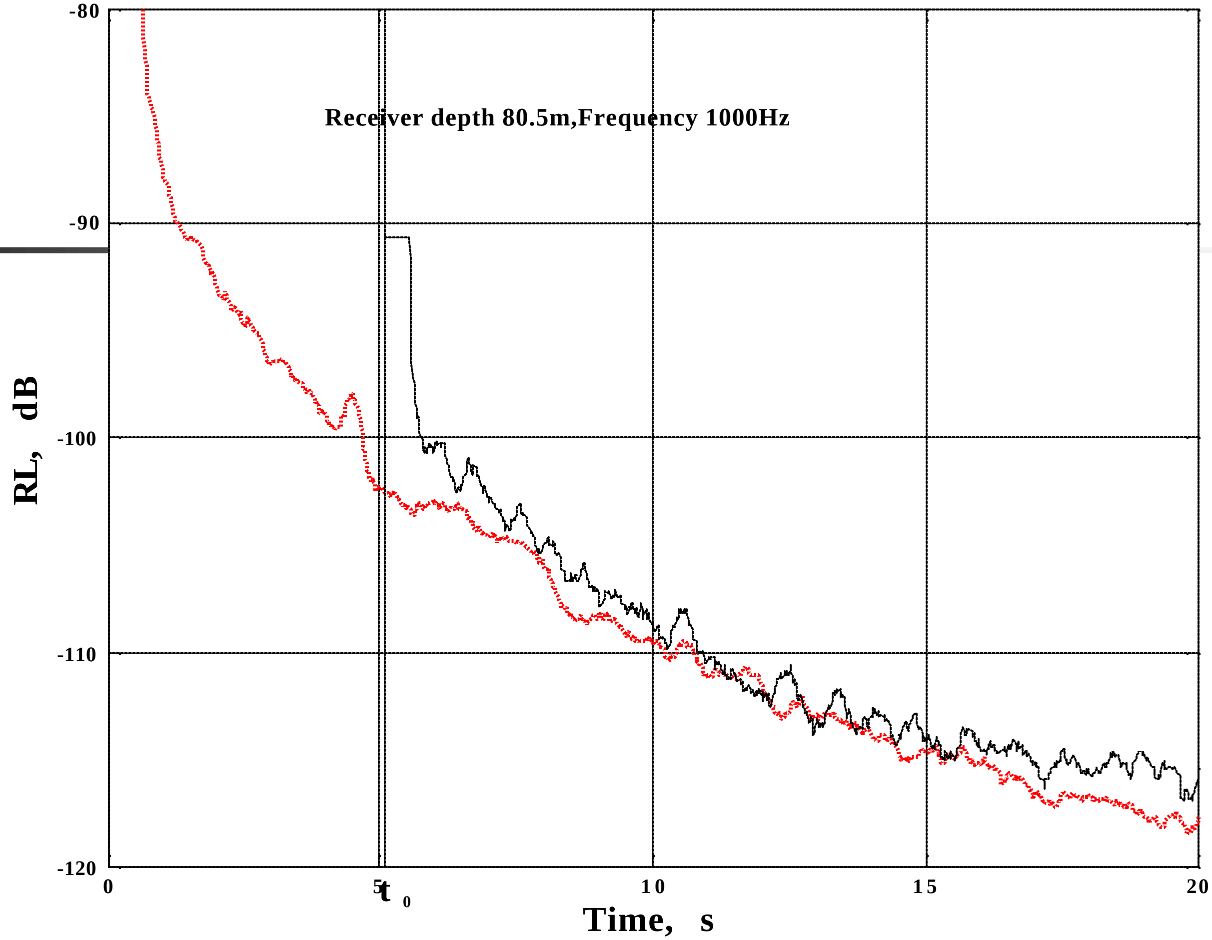

Fig9. Comparison of monostatic(red) and biastaic(black) reverberation loss, receiver depth 80m,frequency 1000Hz.

$t_0 = r_0/c = 5.1s$, $r_0 = 7.6km$

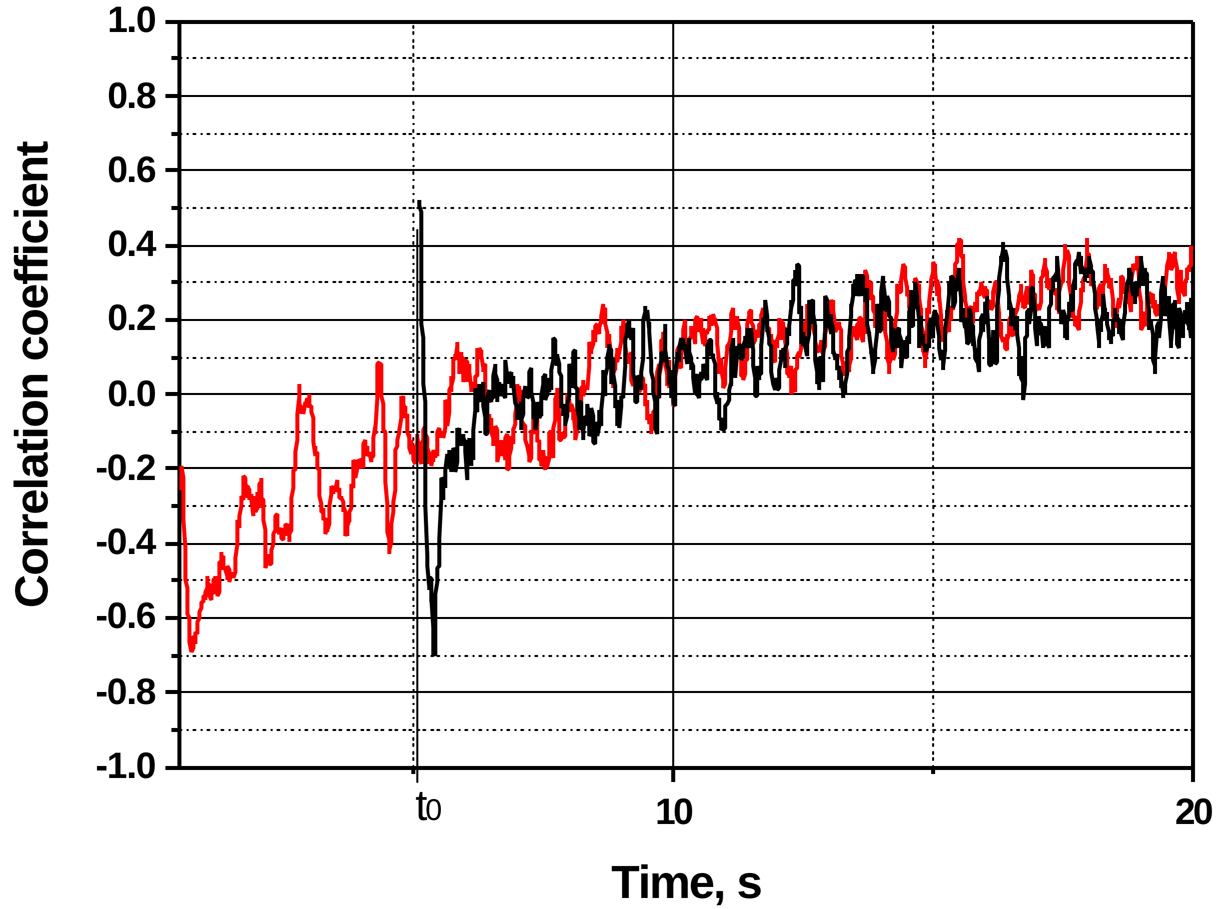

Fig10. Comparison of monostatic(red) and bistatic(black) reverberation vertical correlation, receivers depths: 80.5m and 82.5m, frequency 1000Hz. $t_0=r_0/c=5.1s$, $r_0=7.6km$

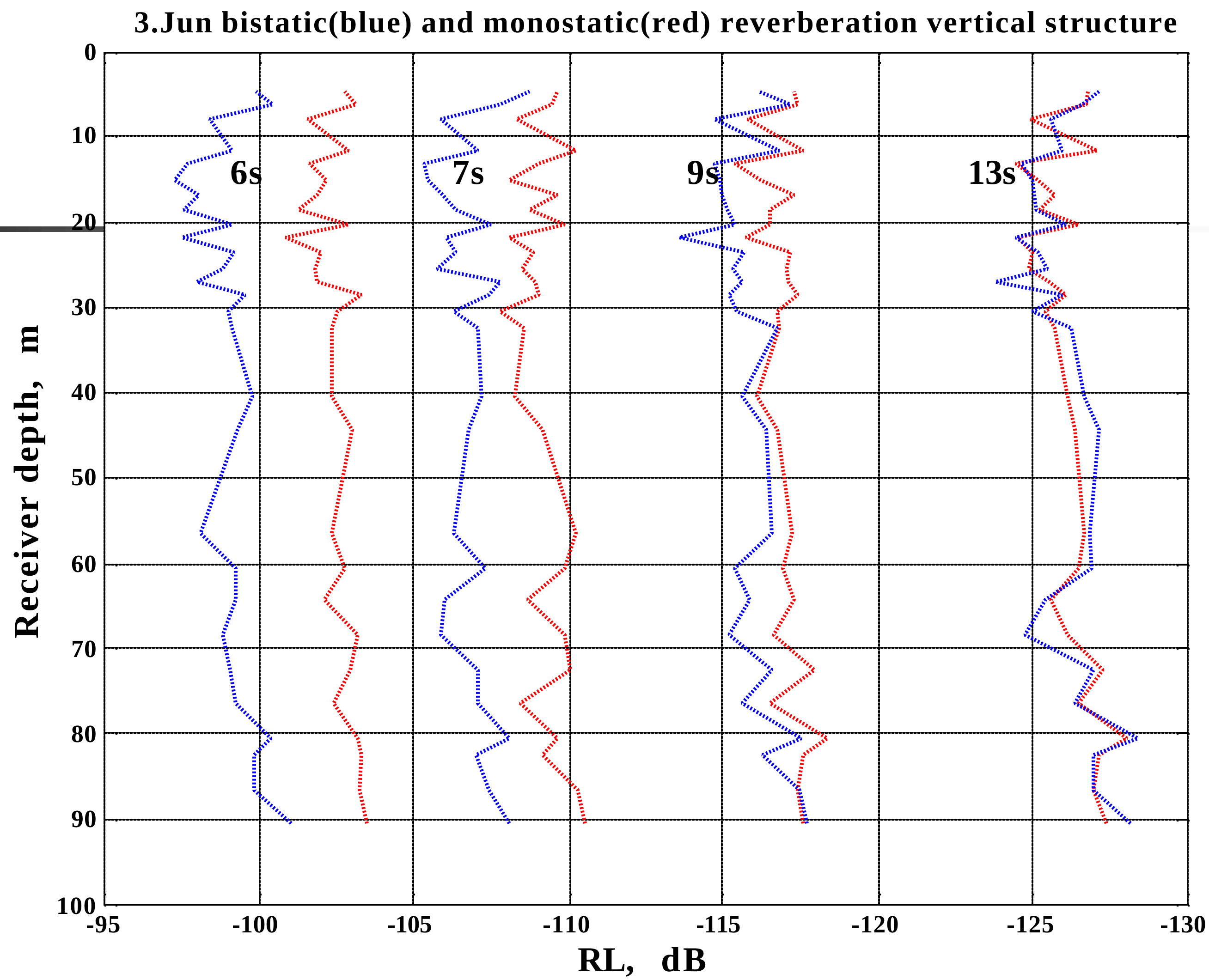

Fig11. Comparison of monostatic(red) and bistatic(blue) reverberation vertical structure. Frequency 1000Hz

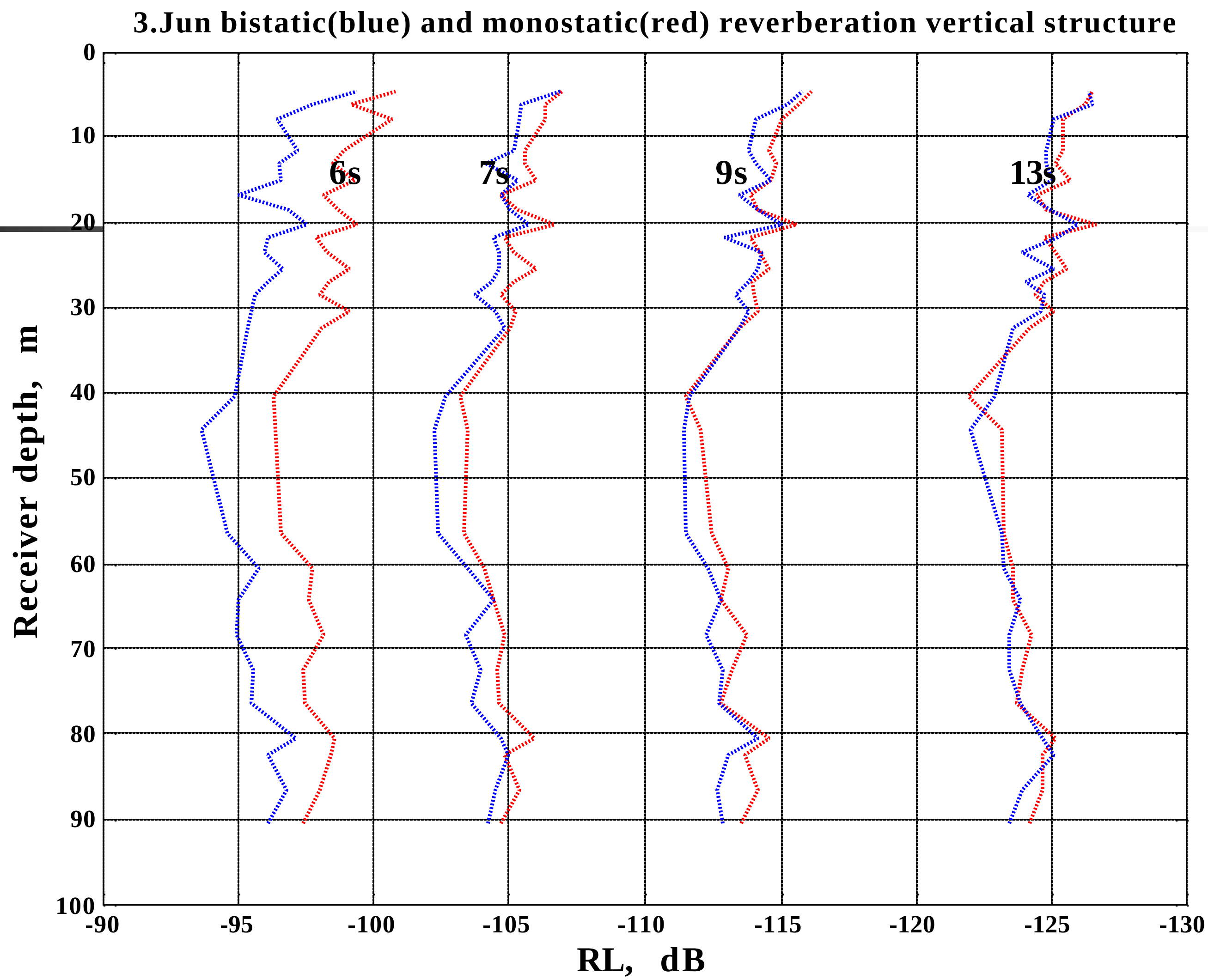

Fig12. Comparison of monostatic(red) and bistatic(blue) reverberation vertical structure. Frequency 2000Hz

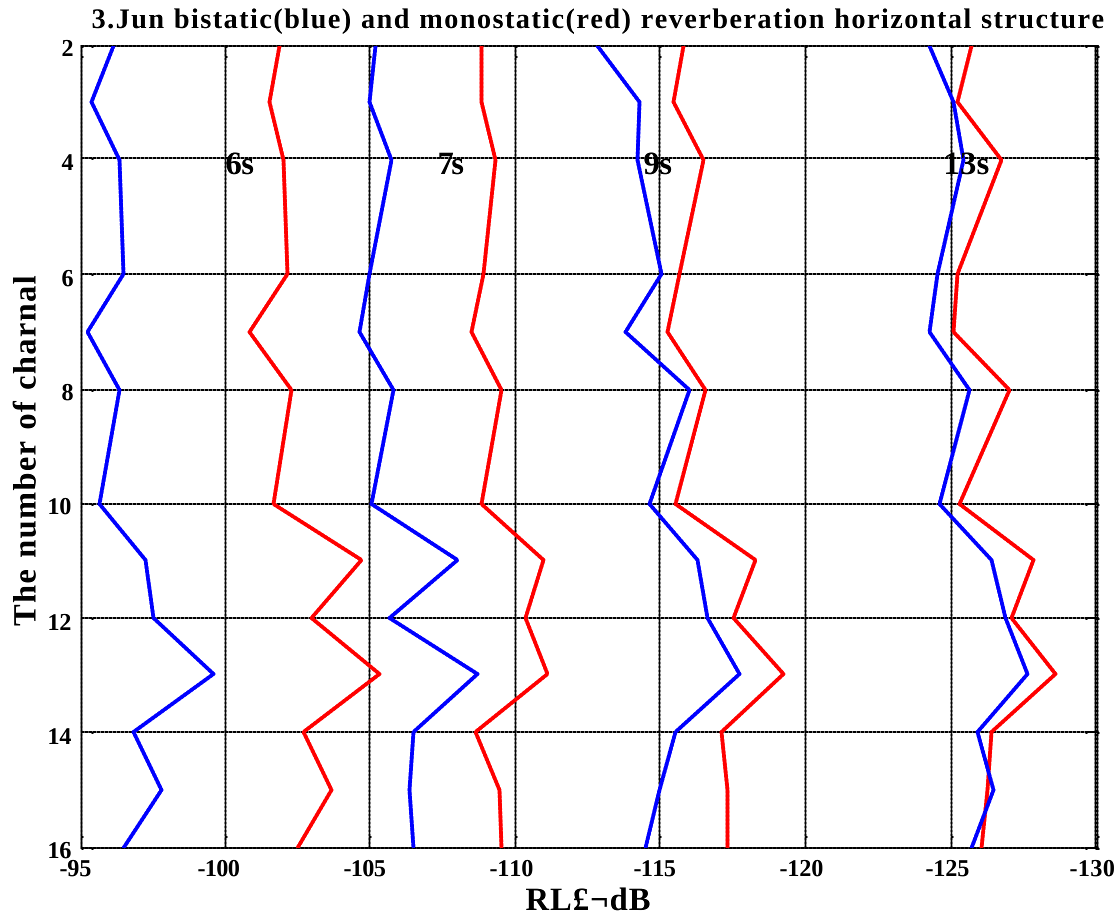

Fig13. Comparison of monostatic and bistatic horizontal structure, Frequency 1000Hz. Receiver depths are all 40m.

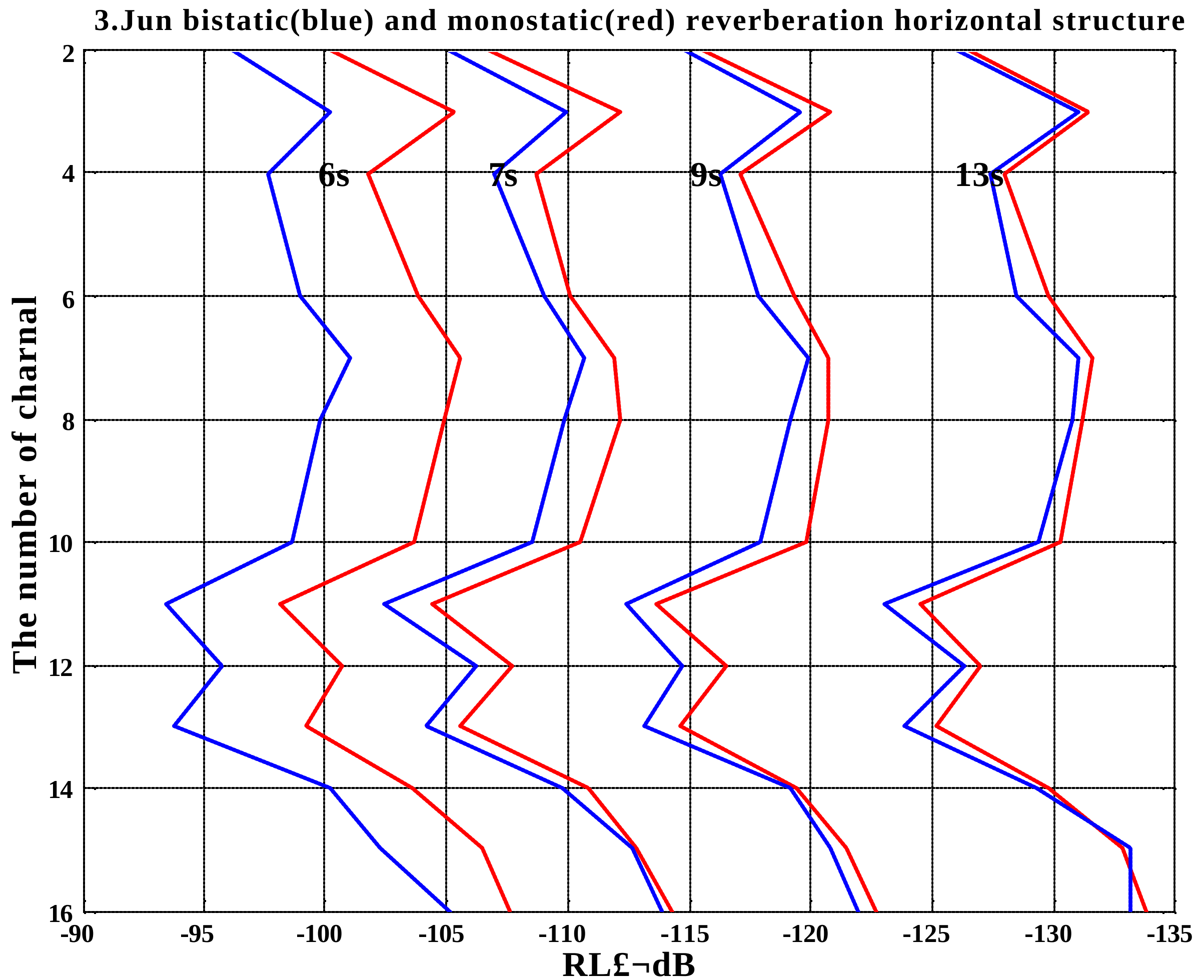

Fig14. Comparison of monostatic and bistatic horizontal structure, Frequency 2000Hz. Receiver depths are all 40m.

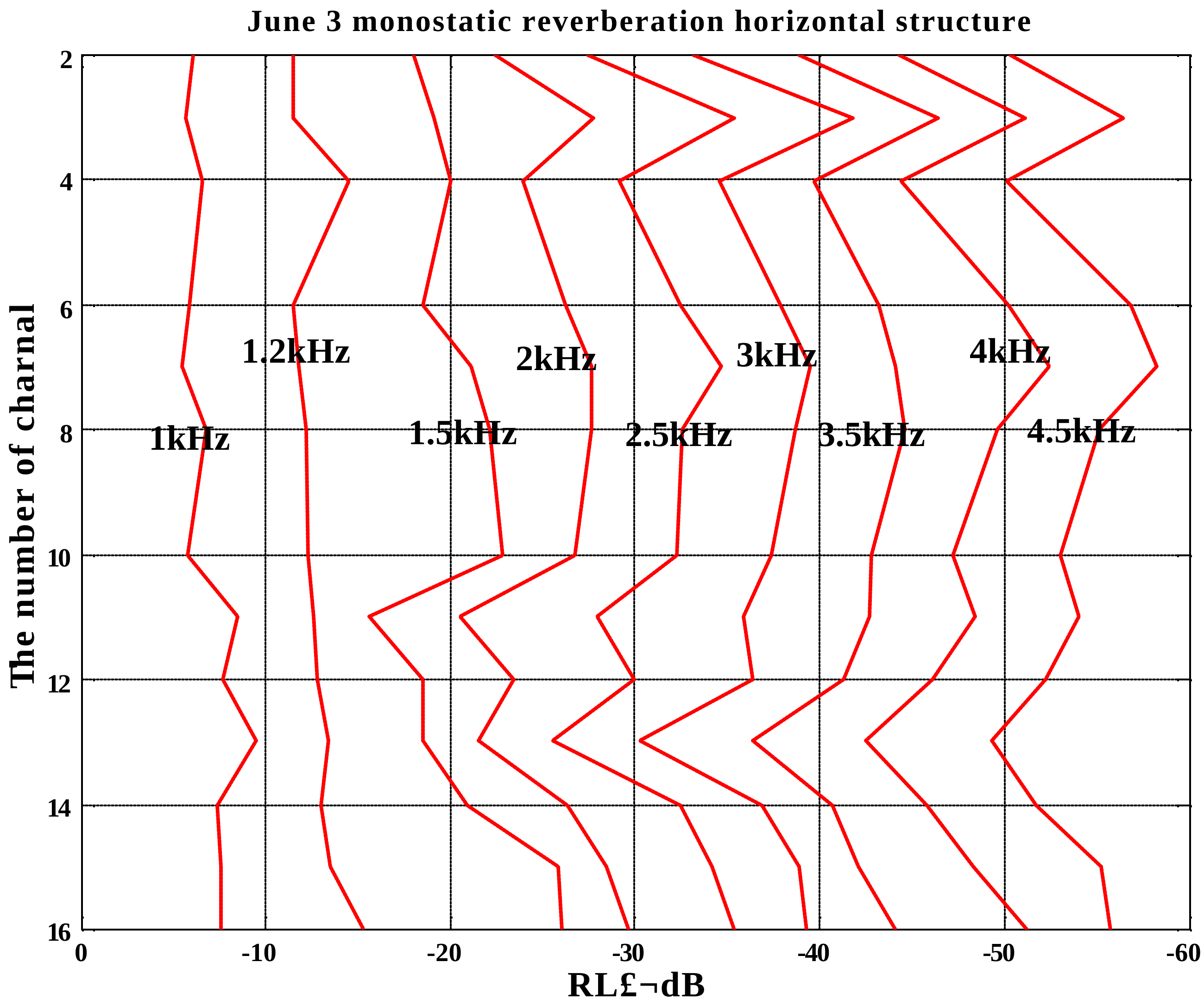

Fig15. Comparison of different frequency monostaic reverberation loss received by horizontal array in June 3.

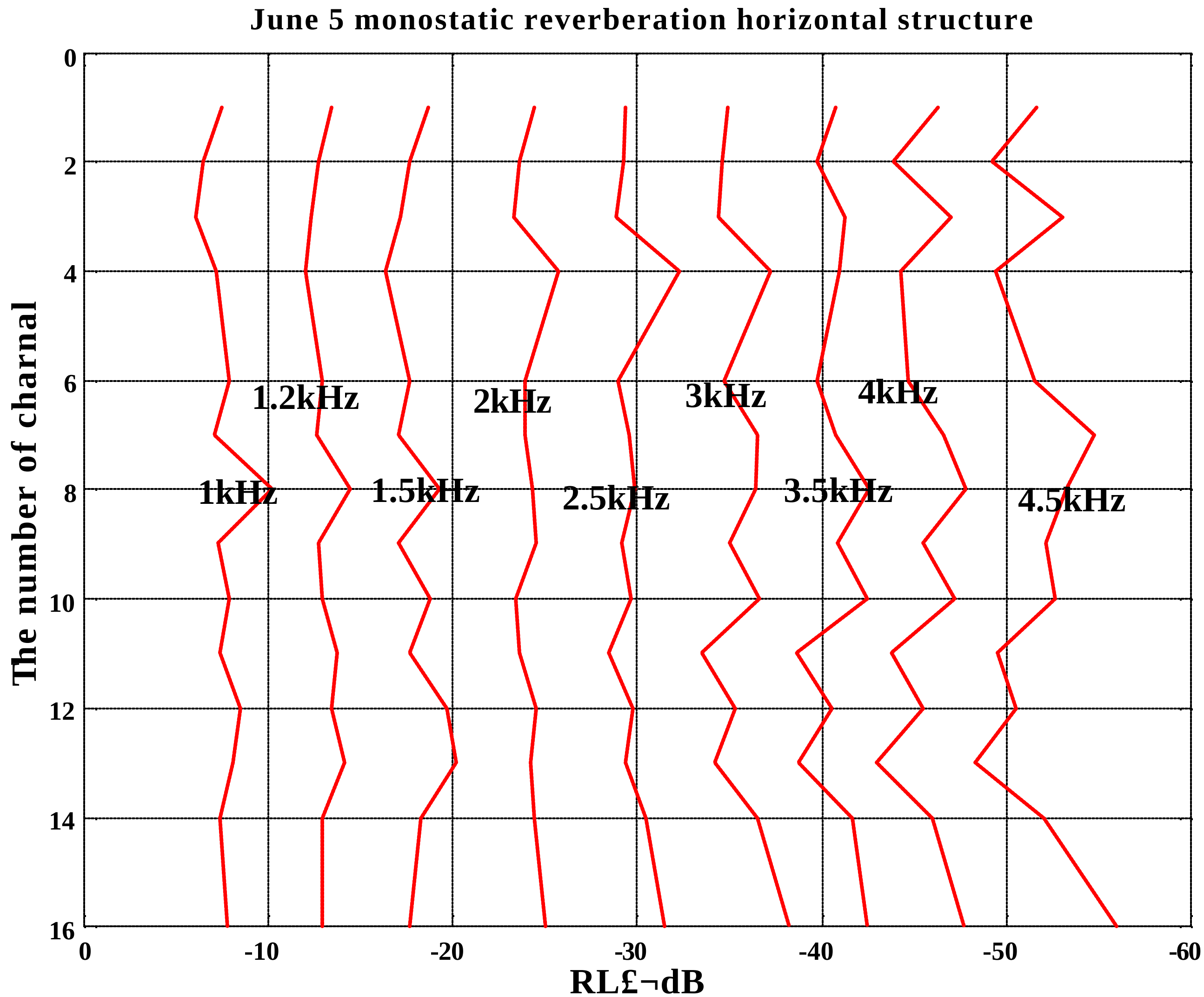

Fig16. Comparison of different frequency monostaic reverberation loss received by horizontal array in 5 June.

The profiles of sound speed

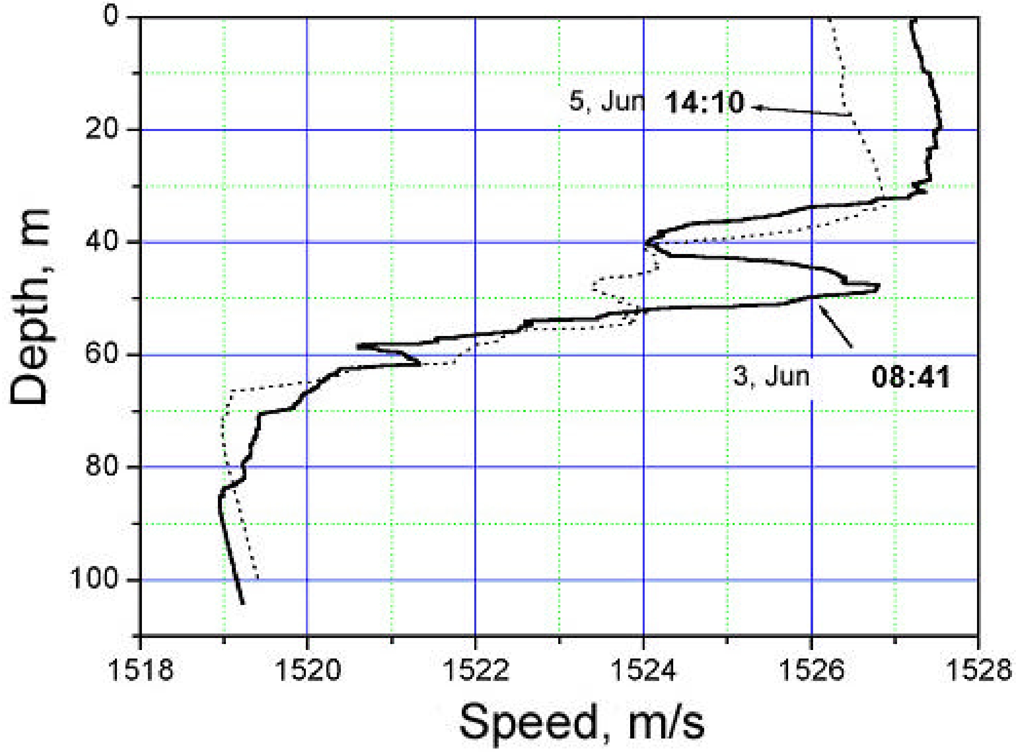

Fig17. The June 3(line) and June 5(dot) profile of sound speed during reverberation experiment

4.Horizontal direction

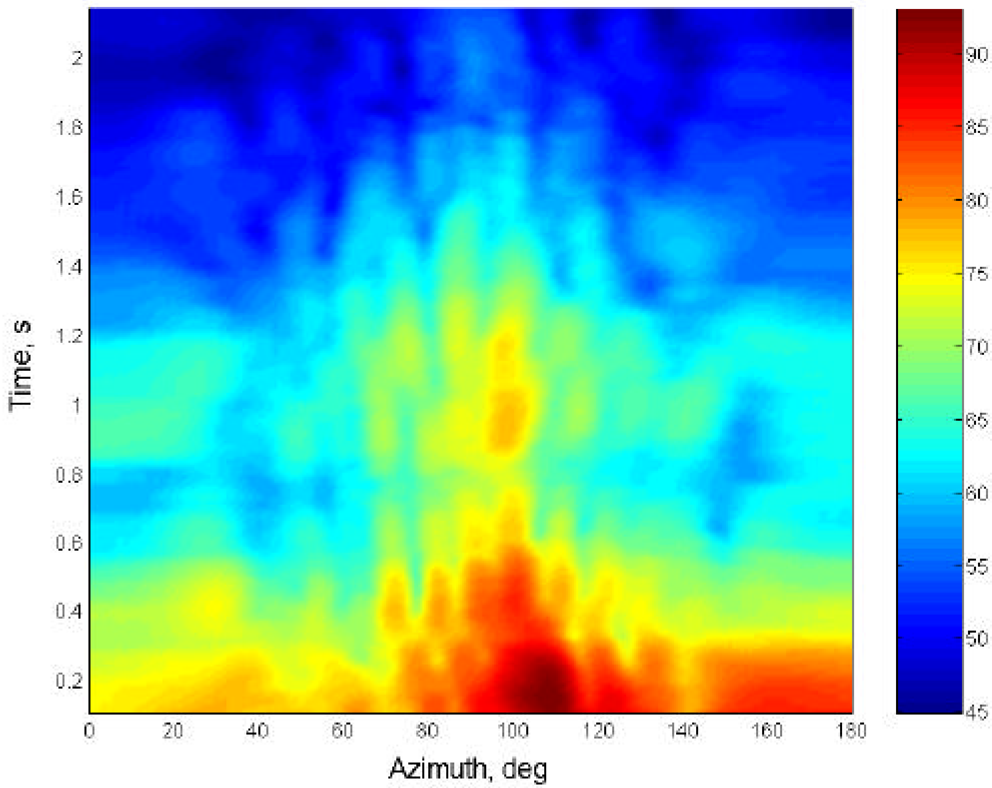

Fig18. Horizontal direction of monostatic reverberation, Frequency 80Hz

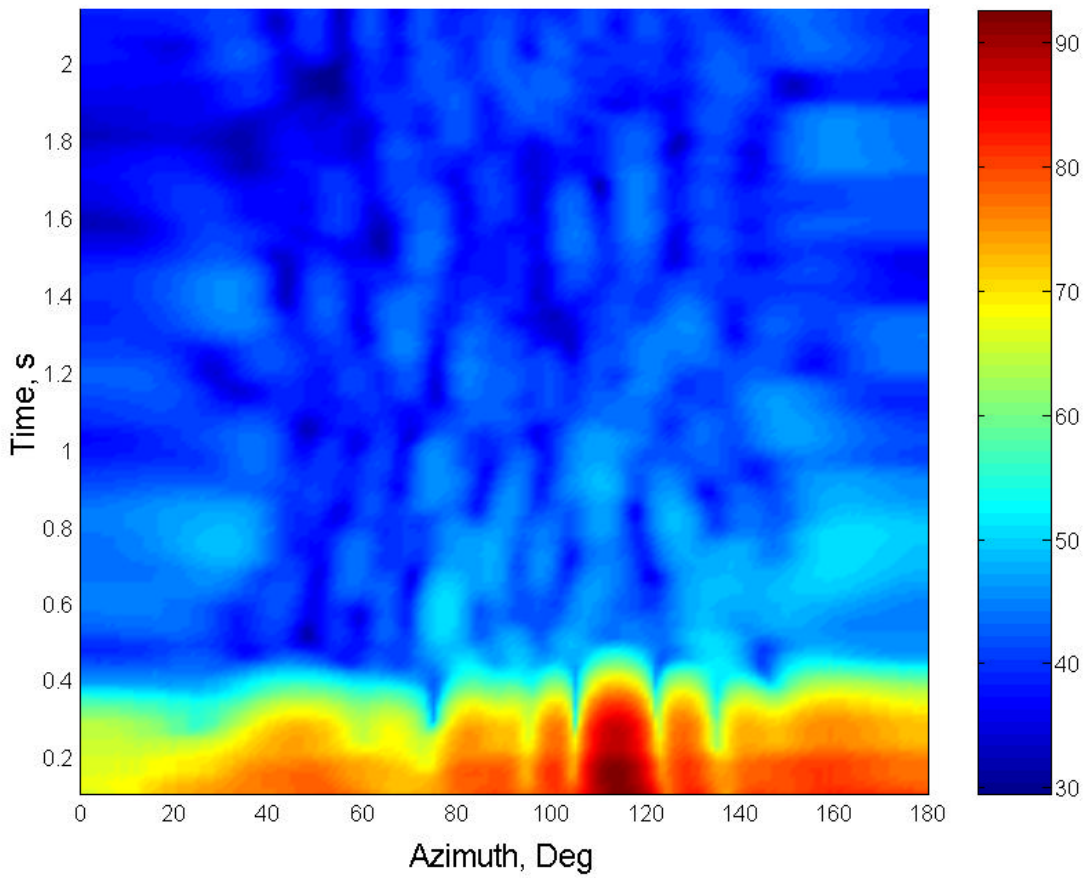

Fig19. Horizontal direction of bistatic reverberation,
Frequency 80Hz

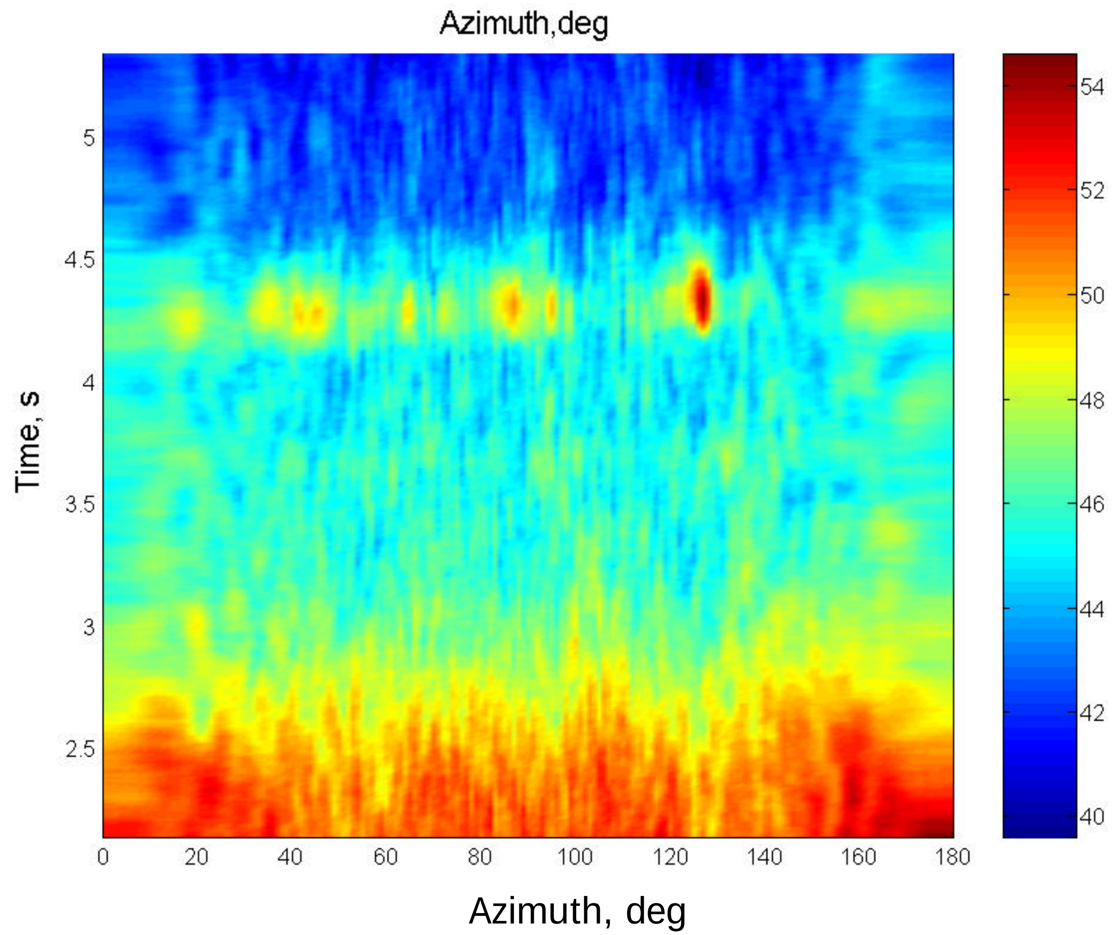

Fig20. Beam form of Jun. 3 reverberation.
Band width 250Hz-450Hz.

Discussion

- 1) 1kg bomb SL can be estimated by comparing its reverberation strength with that of 38g bomb;
- 2) When $t > 2r_0/c$:

  $I_{bi}(t) \sim I_{mo}(t + r_0/c); ?_{bi}(t) \sim ?_{mo}(t + r_0/c)$
- 3) Why June 3 reverberation has horizontal structure? Studying further!
- 4) Monostatic reverberation is stronger at 90 degree azimuth. Bistatic reverberation can not be distinguished clearly.
- 5) There is a target in the distance about 3.3km at 130 degree azimuth.

Thanks